

An overview of IQOS® as a new heat-not-burn tobacco product and its potential effects on human health and environment

Benay Can Eke¹, Rahman Başaran², Naile Merve Güven¹

¹Department of Pharmaceutical Toxicology, Ankara University, Ankara, Turkey

²School of Chemistry, University of Leeds, Leeds, United Kingdom

Abstract

Tobacco smoke from regular cigarettes contains a number of harmful chemicals such as nicotine, arsenic, benzene, carbon monoxide, heavy metals, and tobacco-derived nitrosamines. About 1% of over 7000 chemical substances formed by burning tobacco are identified as the leading causes or possible risk factors of smoking-related diseases such as lung cancer, cardiovascular diseases, and emphysema. The concept of heating tobacco without combustion and smoke has been designed for more than two decades. The products developed with this idea, known as “Heat-not-Burn” tobacco cigarettes, were first introduced in the late 1980s but did not achieve commercial success. However, the tobacco giants have been trying to remarket the tobacco heating systems with new technological and modified features for over ten years. IQOS® (I-Quit-Ordinary-Smoking) is one of the latest heat-not-burn tobacco products that was first launched in Japan and Italy. The company then submitted to the FDA as a modified-risk tobacco product application to sell its own tobacco-heating device IQOS® under its Marlboro® brand in the USA with reduced-risk claims in 2016, but it was rejected. This device is, however, now sold in more than four dozen countries. There are some striking claims that IQOS® which is described as a novel hybrid product between traditional cigarettes and electronic cigarettes; offers an alternative way to substantially reduce the amount of harmful components compared with traditional cigarettes by its new technology in which tobacco is heated up to 350 oC instead of burning it; produces the vapor containing nearly 90 % less toxic substances than cigarette smoke; is not a source of secondhand smoking without negatively affecting indoor air quality. The purpose of this article is to objectively review the potential effects of IQOS® on human health and environment by searching and integrating the published research findings.

Keywords: IQOS®, Heat-not-Burn Tobacco Products, Cigarette, Nicotine, Smoking

The combustion of tobacco generates inhalable toxic chemicals that are cause some deadly diseases, notably cancer. Tobacco companies have long been developed products such as e-cigarettes and nicotine replacement therapy to prevent burning. In response to the scientifically-

proven harmful effects of traditional smoking, Heat-not-Burn tobacco products as a new attack of tobacco industry are gaining popularity and taking over the markets. While hot debates still continue over the use of such devices, Philip Morris International (PMI) has embarked upon marketing a new generation Heat-not-Burn tobacco product, called iQOS[®] (I-Quit-Ordinary-Smoking), which is claimed to have revolutionary technology that heats tobacco instead of burning it. PMI's claims that this product gives the real taste of tobacco with no fire, no ash, and less smoke as well as it eliminates the undesirable effects related to smoking by reducing the level of toxic chemicals.¹ iQOS[®] consists of three main components - a tobacco stick (called HeatStick), a battery-powered tobacco heating holder and a charger. It is used by inserting the disposable tobacco stick in a slot and then heating it at temperatures below 350 °C. The holder provides heat to a tobacco unit for about 6 minutes or 12-14 puffs. The most important difference between iQOS[®] and traditional cigarettes is that despite tobacco in a regular cigarette is burned at above 600 °C, iQOS[®] just heats tobacco up to 350 °C. It has long said that iQOS[®] does not release smoke containing unhealthy components due to not burning tobacco at high temperatures, and it prevents users from exposure to same levels of carcinogens and toxic chemicals found in a conventional cigarette.^{2,3}

More than \$3 billion has been spent over 10 years period in research and development to produce and design of new devices like iQOS[®], according to PMI's statements, and pilot schemes for iQOS[®] then began in Italy and Japan during the late 2014.² However, it was required FDA approval to have been marketed the device in America as a less harmful product than continuing to smoke cigarettes in accordance with its commercial purposes. PMI filed modified risk tobacco products applications (Modified Risk Tobacco Product, MRTP) for three different iQOS[®] cartridges (Marlboro HeatSticks, Marlboro Smooth Menthol HeatSticks and Marlboro Fresh Menthol HeatSticks) with the U.S. FDA (U.S. Food and Drug Administration) on 5th December 2016. PMI's claims in this application are as follows: completely switching from cigarettes to iQOS[®] considerably reduces the risk of tobacco-related diseases and would cause less harm than regular smoking by significantly preventing the exposure of harmful or potentially harmful chemicals.^{4,5} The FDA's Tobacco Products Scientific Advisory Committee discussed the MRTP applications in January 2018 and rejected the proposal that iQOS[®] should be marketed more healthier than traditional cigarettes in the US,^{6,7} but the product is currently being sold in more than 40 countries.²

There is no legal regulation in respect of using iQOS[®] in our country. Smoking accounts for 27% of deaths⁸ and 120 000 people (one person in every five minutes) die every year in Turkey due to tobacco and tobacco-related diseases. Therefore, all kinds of legislation of practice that our country will put into place regarding cigarettes and tobacco products are of utmost importance. Turkey has been fighting a running battle against tobacco since 2008. As smoking-related regulatory efforts have been correctly addressed to achieve sustainable progress, Turkey has become the first country to achieve the highest level of implementation for all six World Health Organization (WHO) tobacco control policy measures (Monitor-Protect-Offer-Warn-Enforce-Raise). After implementation of comprehensive laws in 2009, the overall rate of smoking, which was 31.2% in 2008, decreased to 27% in 2012⁹ and 23.8% in 2015, and it is estimated that this ratio will drop to 19% in 2025 in Turkey.¹⁰ In addition to these advances, the exposure prevalence in workplaces and restaurants decreased considerably from 37% and 56% in 2008 to 16% and 13% in 2012, respectively. Despite the smoking ban in enclosed public spaces in Turkey, the rate of passive smoking is still over 50% in total because the exposure to smoke at homes is quite high (38.3%).¹¹ Cigarette smoke, also called as passive smoking or environmental tobacco smoke, contains seventy-two fully characterized carcinogens¹² as well as at least six toxic substances that are toxic to reproduction. Secondhand smokers inhale the combination of the smoke exhaled by an active smoker and the smoke from burning cigarette, they are more exposed to these toxic chemicals than regular smokers. Furthermore, there is no known safe level of exposure to passive smoking.¹³ The legal regulation is therefore necessary for iQOS[®] which does not have a risk assessment in our country.

As IQOS[®] has a short (four-years) history, there are not enough studies on the effects of the product on human and environmental health. As investigations on iQOS[®] carried out only by the producing company and its competitors in those years and it has been driven the need for more independent scientific data about its safety, the number of research over this product has been increasing considerably in recent years. Given the discouraging laws that are enforced in many countries to protect people from passive smoke of tobacco products, the claims that iQOS[®] does not release harmful fumes makes it an attractive device to smokers, and the adverse health effect will reduce if the tobacco are consumed only by heating without burning. The hazardous constituents of tobacco smoke are related to the intake of a large number of chemical substances resulting from the completed combustion (pyrolysis) and heat decomposition (thermogenic degradation) of tobacco. Eight volatile organic compounds (VOCs) and thirteen polycyclic aromatic hydrocarbons (PAHs) have been released by iQOS[®]. Although almost all

of them are present in moderately to greatly lower than conventional cigarettes, a number of cancer-causing chemicals are still in iQOS[®] emission. The levels of nicotine, benzaldehyde, and formaldehyde were 84%, 50%, and 74% of those from a typical cigarette, respectively. However, acenaphthene was found at levels 295% of that released from a regular cigarette and its effects on human health are not known. Based on the idea that there should be a threshold value for toxic effects of passive smoking should be rejected, according to Principle 1 for implementing article 8 of World Health Organization convention on tobacco control, it is argued that iQOS[®] cannot be considered as a different product from traditional cigarettes and this device should fall under the same smoking bans for regular cigarettes.¹⁴

Based on the claim that iQOS[®] can prevent passive smoking, Protano et al., in 2016, have compared the profiles of passive smoking exposure by measuring the submicronic particles (SMP) generated by the use of traditional cigarettes, iQOS[®], and electronic cigarettes. SMPs emitted from traditional and hand-rolled cigarettes during smoking and also accumulated in the respiratory system of passive smokers were observed four times higher than those released from electronic cigarettes and iQOS[®]. These particles produced by conventional and hand-rolled cigarettes have been found to remain long time in the environment after smoking. It has been reported that the concentrations of these particles, which are emitted from electronic devices and iQOS[®], rapidly return to their previous state and their mean diameter increases by combining with each other, and therefore they precipitate immediately. In addition, SMPs produced as a result of combustion have been observed to maintain their dimensions and therefore they have been suspended in the air for a long time. They also stated that about half of these accumulated particles were small enough to reach the alveoli of passive smokers.¹⁵ Contrary to this research which shows that iQOS[®] smoke can be less harmful than traditional cigarettes, Bekki and his co-workers has found different findings for iQOS[®] in 2017. In this study, the harmful compounds such as nicotine, carbon monoxide, tar and tobacco-specific nitrosamines in iQOS[®] tobacco and smoke were explored and their concentrations were compared with reference cigarettes such as 1R5F and 3R4F. The nicotine concentration in iQOS[®] tobacco and smoke was observed almost same as that of traditional cigarettes, and nitrosamine and carbonmonoxide were found at levels of one-fifth and one-percent that of regular cigarettes, respectively. Toxic compounds has been reported to present in iQOS[®] vapor, even they are at low levels.¹ Farsalinos and his colleagues has demonstrated that the nicotine concentrations in iQOS[®] tobacco sticks are roughly similar to that of traditional cigarettes and are higher than electronic cigarettes when the puff time is short.¹⁶ On the other hand, the size

and volatility characterization of the particles were also calculated by measuring their concentration and distribution in iQOS[®] aerosol. The particle concentration in iQOS[®] smoke was observed less than 1×10^8 particles/cm³, but their size distribution was found about 100 nm. However, it has been shown that as the temperature rise, the particle size distribution has dropped roughly to 20 nm (300 °C) and the volatility of particles has increased. The amount of non-volatile particles breathed by iQOS[®] users was calculated 1-2 mm² per puff in regard to the surface area of the particles. This was 4-fold higher than the amount inhaled by electronic cigarette users.¹⁷

It is predicted that there may be a positive correlation between the use of this product and the occurrence of respiratory diseases. A study evaluating the relationship between iQOS[®] and the expression of nasal platelet activating factor (PAFR) which is effective to adhesion of bacteria causing respiratory tract infection was observed that PAFR expression significantly increased in nasal epithelial cells after iQOS[®] exposure and bacterial adhesion to nasal epithelial cells thus increased.¹⁸ Particularly, this study has also provided an evidence that the use of iQOS[®] increased the vulnerability to respiratory tract infections and infection-induced asthma attacks. Sohal et al. (2019) have investigated the effect of e-cigarette, tobacco smoke and iQOS[®] on human lungs in vitro. The data obtained from the current study show that mitochondrial respiration function alters in consequence of iQOS[®] exposure, as in e-cigarette and traditional cigarette exposure. Mitochondrial dysfunction may further lead to respiratory infections, airway remodelling and lung cancer by stimulating epithelial mesenchymal transition, as seen in chronic lung diseases. iQOS[®] is also thought to enhance infections by increasing microbial adhesion to the airway. The present study has highlighted for the first time that exposure to iQOS[®] smoke is as harmful as cigarette and electronic cigarette for human lung cells.¹⁹

There are also very limited scientific data about the potential effects of iQOS[®] on the environment. Given the fact that air pollution caused by cigarette smoke is ten times higher than that formed by a diesel engine,²⁰ it is of great importance to identify the possible harmful effects of iQOS[®] on the environment. In this regard, when the emission factors of many air pollutants were calculated to quantify harmful compounds released to the atmosphere, the metal emission values for iQOS[®] were observed relatively low compared to traditional and electronic cigarettes. However, some n-alkanes and organic acids have been emitted in significant amounts, whereas polycyclic aromatic hydrocarbon compounds could not be detected in iQOS[®]

smoke. Even though the emission of these toxic compounds is lower than traditional cigarettes, this product is not without risk to environment.³

According to the results of a survey on the awareness and use of this new tobacco product offered for sale under striking advertising slogans such as Heat-not-Burn, approximately 20% of 3086 participants aged 15 and over have knowledge about iQOS[®]. While the number of non-smokers among the people who tested previously iQOS[®] was similar to that of active smokers, the number of non-smokers who want to try this product was higher than that of the current users.²¹

Since iQOS[®] is a new device, it is assumed that there will be some risky situations related to its usage. When the possible risks of the filter and its cleaning on human health are examined, the polymer film filter in the tobacco unit has observed to easily melted during the use (90°C), and even at low amounts formaldehyde cyanohydrin, which is a very toxic substance, has been formed. Researchers has highlighted that iQOS[®] is not just a product that only heat tobacco because iQOS[®] tobacco appears as charred, and this toxic compound also increased when it was not cleaned after each use. The product has also been reported to have limitations that would affect the application of ISO 3308 standard smoking protocols.²²

In order to make a general conclusion about iQOS[®] that is named as a device which meets technology with tobacco, there are not enough research-based findings yet. Especially taking into account that it is a youth-appealing product with its technological design, there are big concerns owing to the fact that there is no universally accepted risk assessment behind it. Unlike the company's claims, the presence of PAHs in iQOS[®] aerosol can be a sign of burning tobacco. Although it is still unclear what the exact harmful effects of this device, there is a small consensus that it is less risky than continuing to smoke cigarettes. However, it is also underlined that toxic chemicals are still present in iQOS[®] smoke and the product could lead people to take up smoking cigarettes. Therefore, more scientific research data is needed to reach an objective conclusion about the effects of iQOS[®] on human health and environment. The best way to protect people from passive smoke is to encourage active users to quit smoking completely.

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